

IN THE SPECIFICATION:

Please replace the fourth paragraph, beginning on Page 3 of the Specification and ending on Page 4, with the following replacement paragraph:


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A typical MEA includes a centrally disposed protonically conductive, electronically non-conductive membrane ("PCM"). One example of a commercially available PCM is [Nafion] NAFION® a registered trademark of E.I. Dupont de [Nours] Nemours and Company, a cation exchange membrane comprised of perfluorosulfonic acid, in a variety of thicknesses and equivalent weight. The PCM is typically coated on each face with an electrocatalyst such as platinum, or platinum/ruthenium mixtures or alloy particles. On either face of the catalyst coated PCM, the electrode assembly typically includes a diffusion layer. The diffusion layer functions to evenly distribute the liquid fuel mixture across the anode in the case of the fuel, or the gaseous oxygen from air or other source across the cathode face of the PCM. In addition, flow field plates are often placed on the surface of the diffusion layers which are not in contact with the coated PCM. The flow field plates function to provide mass transport of the reactants and by products of the electrochemical reactions, and they also have a current collection functionality in that the flow field plates act to collect and conduct electrons through the load.

Please replace the first and second paragraphs, starting on Page 4 of the Specification and ending on Page 5, with the following replacement paragraph:


Conventionally, the diffusion layer is fabricated of carbon paper or a carbon-cloth, typically with a porous coating made of a mixture of carbon powder and [Teflon] TEFLON® coating. However, with time, carbon paper and carbon cloth become saturated in an aqueous environment, which can compromise the transport of water, methanol, and other reactants to and from the active portion of the electrode surface. Carbon paper and carbon cloth can also break down when exposed to methanol for an extended period of time causing a decrease in performance of the fuel cell by failing to appropriately distribute the reactants to the PCM. Furthermore, carbon paper and carbon cloth are fragile and may be crushed or torn easily. This fragility and dimensional instability presents difficulty in handling the materials in a manner which is feasible for commercial volume production of DMFCs and DMFC systems, and can limit the long-term fuel cell and fuel cell system performance stability. In addition, previous DMFC designs have generally required that several layers of carbon paper be placed together to form a single diffusion layer. These diffusion layers can be difficult to work with. Carbon paper and carbon cloth may not present an even distribution of the reactant substances to the MEA, depending upon the material and treatment variances of the carbon paper or cloth.

Present diffusion layers are typically comprised of one or more sheets of porous carbon paper or carbon cloth that are between 100-500 microns thick. It is typically re-



quired that approximately 4-12 sheets of carbon paper be used to fabricate a diffusion layer for a direct methanol fuel cell. Each of these sheets of carbon paper is typically “wet-proofed” with [Teflon] TEFLON® or otherwise treated in a manner that makes the diffusion layer hydrophobic to prevent water from saturating the diffusion layer. If the diffusion layer becomes saturated, it may slow or entirely stop the transport of one or more of the reactants or byproducts to or from the PCM thus limiting the performance of the fuel cell and the fuel cell system. Furthermore, there are form factors and space constraints associated with the small hand-held devices with which the DMFCs are likely to be used, making it critical to minimize the volume of the system.

Please replace the second full paragraph of Page 14 of the Specification with the following replacement paragraph:



Referring to Fig. 3C, a portion of the diffusion layer 322 of Fig. 3B is illustrated (with the remainder of the plate in phantom), but in which the pore sizes vary across the plate. The larger pores, such as pore 330 allow the liquid reactants and by products to pass to and away from the PCM. To further enhance this functionality, the larger pores may be treated with a hydrophilic material. The smaller pores such as pore 332 may be small enough (approx 10 – 40 mils) to allow for gas transport, but not for liquid transport. Furthermore, these pores can, in accordance with the invention, be treated with a hydrophobic substance to repel the aqueous solutions and allow gases to pass through, and re-

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sists water from plugging or saturating the smaller pores, while also resisting the accumulation of carbon dioxide, thus improving the operation of the PCM 7, the fuel cell 3, and the DMFC system. The hydrophobic treatment includes, but is not limited to applying a [Teflon] TEFLON® solution to the smaller pores. A hydrophilic treatment includes, but is not limited to applying a [Nafion] NAFION® solution to the pores. Such pore distributions as illustrated in Figure 3C are very useful for facilitating the anode and cathode reactions by creating discrete and continuous mass transport paths through the metallic component for each of the liquid reactants and byproducts, and the gaseous reactants and byproducts.

Please replace the second paragraph starting on Page 15 of the Specification and ending on Page 16, with the following replacement paragraph:


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In accordance with an alternative aspect of this embodiment of the invention, a metallic diffusion layer 422, 424 (Fig. 4A) is fabricated from a metal with a rough texture and expanded structure (similar to a metallic sponge), which provides an indirect, tortuous path for the reactants to flow to the PCM 7, and the byproducts to flow from the PCM 7. More specifically, the fuel to be introduced to the anode face of PCM 8, or oxygen to be introduced to the cathode face of PCM 10 flows through the porous openings of the metallic layer 422, or 424, respectively and the carbon dioxide and evolved water flow away from the anode and cathode faces of the PCM respectively. The porous metal

diffusion layers shown in Figs. 4A and 4B may be loaded with [Teflon] TEFLON® so that each diffusion layer as a whole is hydrophobic, thus facilitating the release of gaseous reactants and byproducts. Alternatively, the metallic component may be selectively loaded with [Teflon] TEFLON® to create areas of relative hydrophobicity and hydrophilicity as described in Fig. 3E. By doing so, the hydrophobic areas 362 will act to transport gaseous reactants and byproducts from PCM 7, whereas the comparatively hydrophilic areas 364 will facilitate the transport of liquid reactants.

Please replace the paragraph beginning on Page 16 of the Specification and ending on Page 17 with the following replacement paragraph:

A further advantage of the present invention relates to the savings in the size of the overall cell. As noted, direct oxidation fuel cells are being explored as power supply options for small, hand held electronics. Thus, form factors and space constraints are a challenge. The metallic diffusion layers of the present invention are no thicker than carbon paper or carbon cloth diffusion layers. The metallic diffusion layer may be approximately 10 mil (.25 mm) thick whereas the stack of carbon paper sheets would be between 10 and 25 mils (.25-.625 mm) thick. This aspect of the invention may be better understood with reference to Fig. 5. The anodic flow of field plate 526 has approximately a 25 – 40 mil (.625 mm) thickness. The anodic metal diffusion layer 522 is approximately 10 mil (.25 mm) thick. The PCM 512 is approximately 7 mils (.12 mm) thick, the cathode



metallic diffusion layer 524 is approximately 10mils (.25 mm) thick, and the cathode flow field plate 528 is approximately 25 mils (.625 mm) thick. The total thickness of the basic cell components together is approximately 77 mils. The thickness of a typical diffusion layer, which includes carbon paper, would be between about 10 and 25mils, for a total fuel cell thickness of between 77 and 107 mils. [.] Thus, a savings of up to 30 mils is provided by the metallic diffusion layers of the invention, when used as a substitute for carbon paper or carbon cloth diffusion layers.[**]
